MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

EEL2186 – CIRCUITS AND SIGNALS

(All sections / Groups)

23 OCT 2017
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages including cover page with 5 Questions only.

2. Attempt **ALL** questions. The distribution of the marks for each question is given.

3. Please write **ALL** your answers in the Answer Booklet(s) provided, only answers written in the provided Answer Booklet(s) will be considered for marking purposes.

4. Tables of Laplace Transform pairs and properties are available in Appendices A and B for your reference.

Question 1 (10 Marks)

a) Based on tree branch selection, indicate which of the following elements may be selected as a tree branch and/or a co-tree link:

i) Voltage Source

[1 mark]

ii) Capacitance

[1 mark]

iii) Resistor

[1 mark]

b) During the construction of a Fundamental Loop Matrix, explain the two situations when deciding to use "+1" or "-1" in the matrix.

[2 marks]

c) Determine how many trees can be found in the graph shown in **Figure Q1c** (be sure to draw and label nodes and branches clearly in your answer booklet). [5 marks]

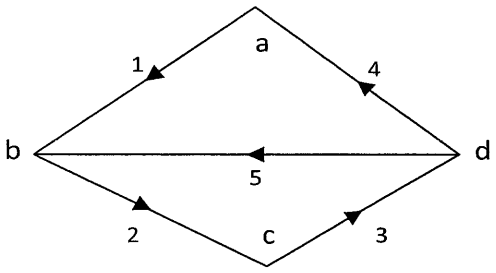

Figure Q1c

Continued...

Question 2 (10 Marks)

a) Find the even and odd components for the following function with clear steps and relevant equations:

$$f(t) = 5t(t+1)$$

[4 marks]

b) Two signals, $f_1(t)$ and $f_2(t)$, are defined as below:

$$f_1(t) = u(t-5), f_2(t) = e^{-t}u(t)$$

If $c(t)$ is the linear convolution between $f_1(t)$ and $f_2(t)$, determine the value of $c(6)$ by evaluating the convolution integral.

[6 marks]

Question 3 (10 Marks)

a) Find the initial value, $f(0)$, and the final value, $f(\infty)$, for $F(s) = \frac{s}{(s+1)(s+4)}$.

[3 marks]

b) For the circuit shown in **Figure Q3b**, determine the total current, $i(t)$ in the circuit when the switch is closed at $t = 0$.

[7 marks]

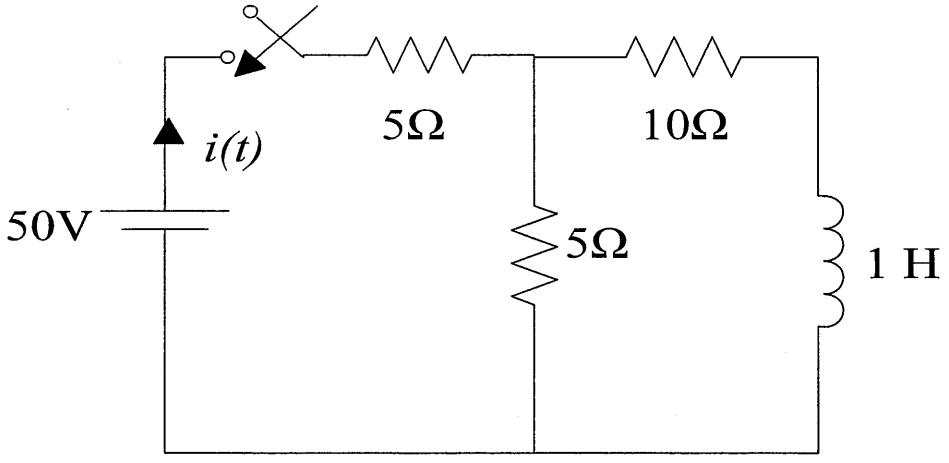

Figure Q3b

Continued...

Question 4 (15 Marks)

a) A two-port network X has z-parameters given by $[z]=\begin{bmatrix}10 & 5\\ 15 & 20\end{bmatrix}\Omega$.

i) The network X is connected as shown in **Figure Q4a**. Determine the currents I_1 and I_2.

[6 marks]

ii) Starting from the connection as shown in **Figure Q4a**, the 100Ω load resistor is next removed from the output terminal (port 2) leaving an open circuit at the output terminal. Determine the current I_1.

[2 marks]

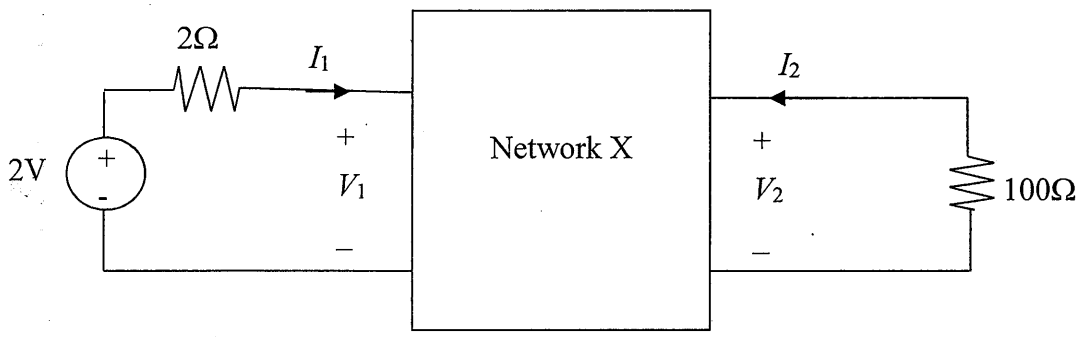

Figure Q4a

b) Determine the transfer function of the electric circuit represented by the following state-equations:

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix}=\begin{bmatrix}3 & -5\\ 1 & -8\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix}+\begin{bmatrix}5\\ -3\end{bmatrix}u(t), \quad y(t)=\begin{bmatrix}-4 & 3\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix}$$

[7 marks]

Continued...

Question 5 (15 Marks)

a) Synthesize the network with impedance function, $Z(s) = \frac{(s^2+1)(s^2+5)}{s(s^2+3)(s^2+7)}$ by Foster second form.

[7 marks]

b) Filter is a circuit designed to pass signals with desired frequencies and reject or attenuate others.

i) What is the difference between passive and active filters? [1 mark]

ii) Sketch and highlight the frequency response difference between Butterworth filter and Chebyshev filter. [2 marks]

c) Based on the following specifications, determine the order of a low pass filter by using Butterworth approximation. [5 marks]

- Maximum allowable pass band attenuation = 2 dB
- Minimum stop band attenuation = 90 dB
- Pass band limiting frequency = 10 kHz
- Stop band frequency = 50 kHz

End of paper.

Appendix A: Table of Laplace Transform Pairs

No.	*t*-domain function	*s*-domain transform
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	t^n	$\frac{n!}{s^{n+1}}$
5.	e^{-kt}	$\frac{1}{s+k}$
6.	$t^n e^{-kt}$	$\frac{n!}{(s+k)^{n+1}}$
7.	$\sin\omega t$	$\frac{\omega}{s^2+\omega^2}$
8.	$\cos\omega t$	$\frac{s}{s^2+\omega^2}$
9.	$e^{-kt}\sin\omega t$	$\frac{\omega}{(s+k)^2+\omega^2}$
10.	$e^{-kt}\cos\omega t$	$\frac{s+k}{(s+k)^2+\omega^2}$
11.	$t\sin\omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
12.	$\sinh\beta t$	$\frac{\beta}{s^2-\beta^2}$
13.	$\cosh\beta t$	$\frac{s}{s^2-\beta^2}$
14.	$\sin(\omega t+\phi)$	$\frac{s\sin\phi+\omega\cos\phi}{s^2+\omega^2}$
15.	$2\lvert k\rvert e^{-\sigma t}\cos(\omega t-\varphi)$, where $k=\lvert k\rvert\angle\varphi$	$\frac{k}{s+\sigma+j\omega}+\frac{k^*}{s+\sigma-j\omega}$
16.	*f(t)* periodic with period T	$\frac{1}{1-e^{-Ts}}\int_0^T f(t)e^{-st}dt$

Appendix B: Table of Laplace Transform Properties

Operations	$f(t)$	$F(s)$
1. Multiplication by scalar	$kf(t)$	$kF(s)$
2. Scaling	$f(kt),\ k \geq 0$	$\frac{1}{k}F\left(\frac{s}{k}\right)$
3. Addition and subtraction	$f_1(t) \pm f_2(t)$	$F_1(s) \pm F_2(s)$
4. Time shift	$f(t-t_o)u(t-t_o)$	$F(s)e^{-st_o}$
5. Frequency shift	$f(t)e^{\alpha t}$	$F(s-\alpha)$
6. Time differentiation	$\frac{df(t)}{dt}$	$sF(s) - f(0)$
	$\frac{d^2f(t)}{dt^2}$	$s^2F(s) - sf(0) - f'(0)$
7. Time integration	$\int_0^t f(\tau)d\tau$	$\frac{1}{s}F(s)$
8. Initial value	$\lim_{t\to 0} f(t)$	$\lim_{s\to\infty} sF(s)$
9. Final value	$\lim_{t\to\infty} f(t)$	$\lim_{s\to 0} sF(s)$
10. Frequency differentiation	$tf(t)$	$-\frac{dF(s)}{ds}$
11. Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(\tilde{s})d\tilde{s}$
12. Convolution	$f_1(t) * f_2(t)$	$F_1(s)F_2(s)$